August 14, 2023

National Highway Traffic Safety Administration
Office of Crash Avoidance Standards
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Washington, DC 20590

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Comments to the Notice of Proposed Rulemaking for the Federal Motor Vehicle Safety Standards: Automatic Emergency Braking Systems for Light Vehicles.
NHTSA–2023–0021

To whom it may concern,

Porsche Cars North America (PCNA) appreciates the opportunity to submit the following comments with regards to the United States Department of Transportation (US DOT) National Highway Traffic Safety Administration (NHTSA) Notice of Proposed Rulemaking (NPRM) for Federal Motor Vehicle Safety Standards: Automatic Emergency Braking Systems for Light Vehicles. These comments are submitted by PCNA for itself and on behalf of Porsche AG (collectively, "Porsche").

Porsche recognizes the potential for injury and property damage reduction that advance safety technologies such as Automatic Emergency Braking (AEB) and Pedestrian Automatic Emergency Braking (PAEB) can provide and is actively working to expand the availability of such systems in Porsche vehicles, where it is technologically feasible to do so.

Porsche continues to play an active role in helping to further develop other global standards related to AEB technology, such as the UN Regulation No. 152 (UN-R 152) standard. Porsche believes that this standard established an important benchmark for AEB technology in helping to ensure robust, balanced safety performance that will bring benefits to drivers and road users throughout global markets. Throughout these comments, Porsche references opportunities for alignment with UN-R 152 and recommends NHTSA seek alignment wherever possible with this established standard. Harmonization of AEB standards and vehicle systems can help speed technologies to market and reduce overall costs for consumers, both of which can accelerate benefits for motorists and road users.

Porsche appreciates the opportunity to now submit the following comments to this NPRM and to help inform the agency's Final Rule for future AEB and PAEB requirements in the United States. Porsche seeks to provide constructive input that will help NHTSA develop an effective and balanced Federal Motor Vehicle Safety Standard to ensure robust AEB and PAEB performance. In general, Porsche views NHTSA's proposal as a significant escalation in the regulated performance requirements for future AEB and PAEB systems. Porsche projects that compliance with these proposed standards will greatly increase the complexity of AEB technology and system integration and could prove extremely challenging for many existing systems and vehicle platforms without complete reengineering efforts. Achieving compliance with the proposed standards and ensuring robust, balanced on-road performance will likely require extensive hardware and software changes that will need lengthy development times and result in increased system costs. As such, these comments aim to provide input to help ensure that, consist with the agency's statutory basis, the Final Rule is practicable and achievable for industry while also delivering incremental safety benefits above existing AEB systems for drivers, passengers, and other road users.

These comments contain Confidential Business Information (CBI) and such sections have been marked accordingly. The redacted version of these comments will be submitted via the Docket at regulations.gov with the confidential version submitted to NHTSA's Office of General Counsel following the procedures defined in Part 512. In addition to these comments, Porsche also participated in the development of comments submitted by the Alliance for Automotive Innovation (AFAI) and supports those positions.

The performance requirements should guard against false activation.

AEB and PAEB are key systems focused on emergency situations where imminent collision is detected. As noted by NHTSA throughout the NPRM, it is important for these types of emergency systems to balance effective operation against false activation or other unexpected performance. Porsche agrees and implements extensive validation and verification processes, considering both functional safety and other potentially hazardous scenarios during development, to help ensure robust and comprehensive system performance to account for the complexities that can be expected to be encountered by drivers in on-road, real-world situations.

While AEB systems are proving highly effective in mitigating the risk and severity of crashes in emergency situations, Porsche recognizes that drivers must continue to ensure the safe operation of their vehicle at all times. In considering increased AEB system requirements, it is important to ensure that AEB continues to serve as a supporting function to assist drivers in emergency situations. However, it is also important to ensure that AEB functions do not compete with or interfere in the decisions that the driver may take to best avoid an accident. Finally, AEB systems must be carefully designed to not encourage drivers to become dependent on such systems to the extent that drivers reduce their attention to safely operating their vehicle, or to otherwise engage in irresponsible behavior.

NHTSA's proposal reflects an ambitious increase in the technical demands on AEB technology that may not be achievable in a robust manner.

NHTSA's proposal builds upon a history of previous work related to AEB including actions such as industry's previous voluntary commitment[1] to deploy AEB technology and by the agency to encourage deployment of AEB through the New Car Assessment Program (NCAP). AEB systems in the field today are providing safety benefits for drivers and other road users. Porsche recognizes the potential benefits of AEB and PAEB systems in helping to reduce the risk of collisions that can lead to injury and property damage and has been actively deploying such systems in its fleet of vehicles. Through this proposal, NHTSA is seeking incremental safety benefits beyond the current generation of AEB systems by proposing an ambitious and challenging increase in the regulated technical performance requirements for AEB and PAEB technology. Furthermore, NHTSA has proposed a rapid implementation timeframe for such systems to be deployed within all new light vehicles.

AEB and PAEB technologies are complex and require careful development to balance robust system performance in avoiding or reducing the severity of crashes while also avoiding false activations and unexpected behavior of vehicles in the real-world. As the performance demands on AEB systems are increased, systems must be developed with additional diligence as the potential for false activation and unexpected braking can increase. Heightened performance requirements may drive additional system hardware needed to detect vehicles and pedestrians at further distances and at greater speeds. This hardware will create more data streams that will need to be analyzed and processed with quicker speed and accuracy in order to make informed decisions. As such, the proposed system performance requirements will likely demand significant reengineering of many existing and near-term AEB and PAEB systems. As demonstrated in NHTSA's supporting technical information, many contemporary vehicles do not possess the hardware and system designs needed to concurrently meet all the proposed standards.

Porsche anticipates that many systems could require extensive hardware updates, including the addition of new sensors, on top of extensive software revisions, for vehicles to meet the proposed requirements and for those vehicles to provide robust real-world performance. Other elements in NHTSA's proposals, such as the expanded visual warnings, will also drive complex reengineering to incorporate new features such as visual Heads-Up-Displays (HUDs) and other warnings. Given the extent of development and validation that lies ahead, Porsche considers that the proposed lead-time may not be practicable. The proposed timeframe may not be sufficient for developers to incorporate new hardware into existing electrical and platform architectures, update system and vehicle software, perform extensive system training and validation, and to ensure continued robust functional safety performance. In addition, as those sensors are often used in other vehicle functions, Porsche must ensure that those sensor systems continue to perform their other duties besides AEB. As NHTSA recognizes in the NPRM, these proposed standards reflect a minimum of expected performance and Porsche must carefully design driver assistance systems to account for a wide range of expected real-world situations.

[1] Commitments to Advancing Automatic Emergency Braking Technology, March 2016

As system complexity increases, ensuring robust functional safety will require more time for development and validation, especially to deliver performance that builds customer acceptance for AEB technology.

In response to these challenges, Porsche provides the following comments, together with comments from the AFAI to provide recommendations on changes to the proposed requirements that may help deliver an effective and achievable final rule. In addition, Porsche outlines proposed lead-time, combined with phase-in and the opportunity for early action incentives to help create a smooth transition for compliance with the proposed standards.

Porsche is implementing an ambitious, transformative electrification architectural strategy.

Porsche, like many manufacturers, is in the midst of a transformative shift towards electrified vehicles that is resulting in unprecedented investments into all-new vehicle architectures that are slated to replace legacy, combustion based, architectures. This transition is driving unprecedented levels of investment and engineering focus across the automotive industry, including companies like Porsche, in order to achieve our shared environmental and energy goals.

Porsche has developed a comprehensive sustainability strategy that is being implemented across our global operations, services, vehicles, and products. Through this strategy, Porsche seeks to ensure that the company continues to be a positive partner to society and that our vehicles will meet the needs and desires of our customers while contributing to the environmental and energy policy goals being established by governments in the markets Porsche serves.

To achieve Porsche's decarbonization goals, many Porsche models are being transitioned from existing "legacy" combustion-based vehicle platforms towards all-new electrification focused architectures. Like many other automobile manufacturers, the level of capital and engineering resources being dedicated towards this electrification transformation is unprecedented in the history of the industry. As outlined in comments submitted by the AFAI to the recent greenhouse gas rulemaking proposal from the Environmental Protection Agency, the global automobile industry is projected to be investing over one trillion dollars into electrified vehicles[2]. Porsche, like many manufacturers, must carefully allocate resources to achieve a successful transition towards electrified vehicles.

The newer architectures underpinning many of the future Porsche electrified vehicles are incorporating wide ranging updates to on-board systems that can facilitate adoption of more complex, higher performance sensing and computing capabilities needed to support more advanced driver assistance and emergency systems. Existing combustion-based platforms will continue to be part of Porsche portfolio for several years, including into the timeframe for compliance proposed by NHTSA in this NPRM. In many cases, these platforms are approaching "end-of-life" and will not be replaced with new platforms since many of the vehicles will transition to the electrification platforms outlined above. Many of these legacy platforms are already delivering safety benefits by featuring AEB systems that comply with levels of performance related to the voluntary AEB commitment and share systems capable of meeting standards such as UN-R 152. However, these architectures would require extensive reengineering to incorporate a more complex array of

[2] Docket # EPA-HQ-OAR-2022-0829

sensing and compute capabilities that may be needed to meet the proposed level of AEB and PAEB performance. Incorporating extensive architectural updates to legacy platforms nearing end-of-life would detract from resources that are otherwise needed to accelerate the shift and scale-up of electrified platforms. This is especially important for Porsche given the parallel policy activities driving the unprecedented acceleration of electrification into the US fleet.

Balancing NHTSA's Diverse Policy Objectives.

In parallel to this proposal for AEB and PAEB, NHTSA has also issued more stringent Corporate Average Fuel Economy (CAFE) standards for manufacturers covering model years that overlap with the proposed compliance timeline of this NPRM[3]. NHTSA's proposed CAFE standards reflect parallel efforts from EPA and State agencies to achieve environmental and energy goals primarily rooted in the assumed acceleration of sales of electrified vehicles in the US. For example, EPA's proposal for greenhouse gas reductions project that over 60% of new vehicles will need to be fully electric by 2030 and nearly two-thirds of the new vehicle market to be electrified by 2032. This is a dramatic increase in the sales for electrified vehicles that today are less than 10% of the total US market. Therefore, it is critical for Porsche to allocate financial and engineering capital towards accelerating Porsche's electrification portfolio to meet binding, regulatory obligations such as CAFE. As mentioned above, diverting resources away from future platforms and back into end-of-life, legacy platforms would detract from the efforts needed to achieve the broad transformation towards electrification.

As discussed in more detail below, Porsche contends that the agency should consider this architectural transformation in consideration of the practicability of the proposed AEB and PAEB standards. Porsche has incorporated this topic into its proposed lead-time and phase-in recommendations and further describes the issue later in the comments. Porsche believes it is important for the agency to holistically consider the issue of transformation in light of the proposed AEB standards and the agency's parallel fuel economy rulemaking. In addition, Porsche recommends NHTSA take an even wider lens by considering the impact of other Federal and State activities, such as EPA's greenhouse gas regulations and California State ZEV mandates[4], which are also driving electrification. Porsche notes that NHTSA has already demonstrated recent precedent in including the effects of other regulations, such as NHTSA's inclusion of the California ZEV mandate in the baseline fleet for CAFE modeling and rulemaking. As NHTSA included the effects of the ZEV mandate in finalizing fuel economy standards, it would be equitable for NHTSA to include the same effects in its consideration of AEB lead-time by recognizing that the ZEV mandate is influencing the focused investment into the electrified architectural shifts and diverting resources back into legacy platforms is not practicable.

Porsche believes that improved safety outcomes and increased fleet fuel economy averages can be achieved in a balanced manner if both policies take into consideration the practicability concerns across all the policies. Extended lead-times, phase-ins and other measures are increasingly important for manufacturers such as Porsche who must plan

[3] CAFE proposal for MY2027-2031 and augural standards for MY2032, Docket # NHTSA-2023-0022

[4] US EPA Light-Duty Vehicle Greenhouse Gas regulation and California Air Resources Board Zero Emissions Vehicle (ZEV) Mandate

for multiple priorities that are each competing for the same engineering resources. Balanced allocation of resources can help ensure that manufacturers such as Porsche can improve safety performance while at the same time executing transformative electrification plans that will reduce the nation's dependence on fossil fuels.

Summary of Porsche proposals for the proposed Part 571.127.

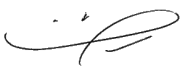
Porsche appreciates the opportunity to provide these comments to NHTSA for the proposed adoption of Part 571.127. This proposal reflects an ambitious increase in the overall technical requirements for AEB and PAEB systems. Porsche is committed to advancing the safety performance of our vehicles in order to further protect occupants and vulnerable road-users. While this proposal has the potential for incremental benefits beyond those being provided by current AEB technologies, Porsche projects that this proposal will require extensive reengineering for many existing AEB systems and vehicle architectures. These comments, together with comments from the AFAI, are intended to help inform the agency's Final Rule in order to promulgate an effective and achievable AEB and PAEB regulation.

In summary, Porsche's comments focus on the following areas:

1) AEB systems are proving to be an effective technology at reducing the likelihood and severity of accidents.
2) NHTSA's proposal will require extensive hardware and software updates to many vehicles which will require high levels of resources devoted to development and validation in order to ensure robust on-road performance.
3) Porsche recommends allowances for manual deactivation and specific operational requirements at higher driving speeds.
4) Porsche outlines a broader lead-time provision, including the use of phase-in and early action credits aimed at providing more flexibility for updating AEB systems.
5) Porsche provides a host of recommendations for lead-vehicle, pedestrian, false activation, and AEB warning details.

Thank you for your consideration of these comments. Should you have any questions, please contact myself or Nick Tamborra at nicholas.tamborra@porsche.us, or 248-464-1836.

Sincerely,



Michael Scott
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Porsche Cars North America

—Appendix A—

Appendix A. Specific Recommendations for the Proposed Part 571.127 and Part 596.

1. Comments Related to the Overall Proposal for Part 571.127.

The following sections provide comments on general aspects of the proposed Part 571.127, such as updated definitions, or provide input on the overall operation of AEB and PAEB as a vehicle system for the customer.

1.1. Recommended updates to definitions in Part 571.127.

Porsche recommends clarifying updates to the core definition in S.4 for *Automatic emergency braking (AEB) system* to ensure alignment between the definition of AEB and the underlying requirements for the system as described in the proposed regulation. The AEB system requirements defined throughout the proposed Part 571.127 require performance metrics specific to mitigating collisions with lead vehicles and pedestrians. The proposed definition for AEB includes reference to "objects" and "road users". Porsche recommends NHTSA remove the term "object" as the activation of AEB to mitigate collisions with objects generically are not included in the performance specifications for Part 571.127. Rather, as outlined in S5.3 and S9.2, the vehicle is required not to apply the AEB system in relation to certain objects such as a steel trench plate. The inclusion of the term "object" could introduce confusion as to whether the system should be applying braking or specifically not applying braking as required by the false activation section. With regards to the term "road user", Porsche recognizes that the scope of the proposed AEB regulation considers pedestrians and is not more broadly inclusive of other road-users such as bicyclists. To help ensure alignment of the definition of AEB with the scope of required performance of AEB systems, Porsche recommends NHTSA replace the term "road user" with pedestrian.

Porsche recommends NHTSA update S4. Definition, Automatic emergency braking (AEB) with the following:

> *"S.4 Definitions*
>
> *Automatic emergency braking (AEB) system is a system that detects an imminent collision with* ***vehicles and pedestrians*** *in or near the path of a vehicle and automatically controls the vehicle's service brakes to avoid or mitigate the collision."*

1.2. Support allowance for manual deactivation of AEB.

NHTSA makes note in section VI. of the preamble of driving conditions which may warrant automatic deactivation or manual disablement of AEB systems. As stated,

> "NHTSA anticipates driving situations in which AEB activation may not increase safety and in some rare cases may increase risk."[5]

Porsche concurs with NHTSA and their recognition for limited driving situations in which activation of AEB may not be appropriate in improving safety outcomes, or worse yet, where safety could be negatively impact by the unexpected onset of emergency braking.

Porsche supports the allowance for manual deactivation of AEB systems and believes that it is appropriate for the driver to be able to deactivate the AEB system in anticipation of certain driving conditions. Porsche advocated for manual deactivation allowances under similar global standards such as the UN-R 152 based on similar projected driving conditions. In general, Porsche would be supportive of manual deactivation allowances that align with UN-R 152.

While it is important for AEB to be active under most normal driving conditions, Porsche recognizes that many of our customers will use their vehicles under closed-course, or dynamic track type driving events. In these types of events vehicles will be driven in a highly dynamic manner that could include close proximity to other drivers, barriers, or track equipment. Under these conditions, it is important for the driver to have complete control of their vehicle and that vehicles behave in a manner expected by other drivers and in adherence to commonly applied racing rules. It would be inappropriate for AEB to activate under these types of conditions as the sudden and unexpected engagement of braking could be disruptive for the driver or for the vehicles around the driver. This could result in the driver or other drivers having to take sudden evasive maneuvers at high speed or under highly dynamic conditions. Similar conditions could be experienced by drivers in other environments such as in driving off-road near other vehicles, or natural obstacles, albeit at much lower speeds.

Porsche supports disablement of the AEB that would require active engagement by the driver, such as with a two-step process, and that the act of disabling the AEB be allowed by the driver to be done at low speed. Furthermore, once the AEB is disabled, the disablement should remain in place until reenabled by the driver or following the next "key-off/key-on" cycle[6]. AEB manual disablement could generally follow that of ESC disablement as described in Part 571.126 S5.4, or in a manner aligned with UN-R 152, including:

- Automatic return to activated state following "key-off/key-on" driver shut-down and restarting of a vehicle.
    - Similar to other driver modes of features commonly referred to as a "default on" or "non-latching".
- Potential automatic disablement in other manually enabled driving modes.
    - Such as off-road, sand, snow, etc. where it would be appropriate for various systems, including AEB, to be deactivated as part of that driving mode.

[5] 88 FR 38698

[6] Porsche uses the term "key-off/key-in" in the general sense to imply the act of the driver shutting down the vehicle (e.g., at the end of a drive) and then restarting the vehicle (e.g., for the next trip). Some newer vehicles may not feature a key fob or start button, but could have other means of "key-off/key-in". Furthermore, this should not include vehicle controlled shut-downs such as stop-start technology.

- Disablement should remain in place over the full operation of the vehicle until the AEB is reactivated, or until the following "key-off/key-on" cycle.
- Discouragement of casual deactivation by not allowing a direct single-action hardware button, but instead involving actions taken through a menu screen or HMI system, including multiple steps.
    - Porsche recommends alignment with the two-step process as defined in UN-R 152.
- Other conditions as appropriate.

Porsche is confident that measures to discourage casual deactivation, such as the two-step process outlined in UN-R 152, will ensure that for the vast majority of vehicle miles traveled, drivers should be operating their vehicles with AEB systems active. Porsche contends that the allowance for manual deactivation is an imperative for the safe operation of the vehicle under dynamic conditions and that this allowance aligns with the statement from NHTSA where the agency recognizes that certain conditions warrant deactivation of AEB to avoid unintended risks. Furthermore, Porsche believes that providing drivers with the option to manually deactivate AEB systems will be an important element for overall customer acceptance. Many drivers continue to feel it is important for them to have control over systems in their vehicle in order to account for their personal driving needs.

Porsche recommends NHTSA add clear and definitive allowance for manual deactivation within the proposed Part 571.127 S5., as a new section (d) which could include "Off" allowances and "Off Telltale" requirements, similar to how "Off" allowances are provided for ESC systems in Part 571.126 S5.4. Similarly, a new section S11. could be added. Suggested language for revisions to Part 571.127 are included in **Appendix-B**.

1.3. Support for automatic deactivation of AEB and PAEB systems.

NHTSA makes note in section VI. of the preamble of driving conditions which may warrant automatic deactivation of AEB systems. As stated, "*NHTSA anticipates driving situations in which AEB activation may not increase safety and in some rare cases may increase risk*."[7] Porsche appreciates NHTSA's discussion of driving situations in which activation of AEB may not be appropriate in improving safety outcomes, or in cases in which AEB operation may increase risks. In response to NHTSA seeking comment on automatic deactivation, Porsche provides the following input.

Specific to the conditions generally defined in the preamble (i.e., trailer towing, ESC disablement, and sensor interfering attachments), Porsche generally supports the automatic disablement of AEB and the malfunction indication messages for the driver. Porsche agrees that in cases such as those listed, operation of the AEB may not be appropriate if conditions exist that could disrupt the stability of the vehicle under extreme braking, and in cases where sensors are obscured, it would be impractical for the system to operate as designed. It should be permitted for OEMs to extend the list of automatic conditions for use cases similar to listed ones if necessary. Providing a deactivation warning message to the driver while the system is deactivated is appropriate in order to inform the driver of the system state. Providing

[7] 88 FR 38698

the warning should not be overly intrusive as the range of situations in which the systems would be automatically deactivated should be infrequent and of limited duration.

1.4. AEB operation at high-speed vehicle operation.

At higher driving speeds, generally in excess of the speed ranges in the proposed lead vehicle and pedestrian AEB requirements, AEB systems become increasingly challenged in appropriately sensing and classifying potential collisions. Perception is limited by sensor range, resolution, and processing latency. At high speeds, these technological limits lead to a vastly reduced level of confidence in the assessment of whether emergency braking is justified or not.

Braking distance increases with the square of the velocity. At high speeds, the last point to brake (in order to avoid a collision, "LPTB") lies far in advance of the obstacle. Given the sensory limitations, objects far ahead can be falsely classified, falsely located, or just not detected at all. Human drivers are also challenged by the limits of their perception and reaction time. This is why high-speed driving generally requires the highest possible level of attention.

However, human drivers have an advantage compared to AEB systems. They can base the decision of whether to brake or not on the availability of steering as an option to avoid the obstacle. As illustrated in Figure 1, the last point to steer ("LPTS") does not depend on the braking distance and therefore only increases linearly with speed. When closing in on an obstacle at high speeds, the driver can pass the LPTB with enough time to react and steer clear of the obstacle. As the AEB lacks the information of whether the driver is going to steer or not, it will assume the worst case and initiate emergency braking before the LPTB, far in advance of the obstacle, to avoid the collision through braking alone.

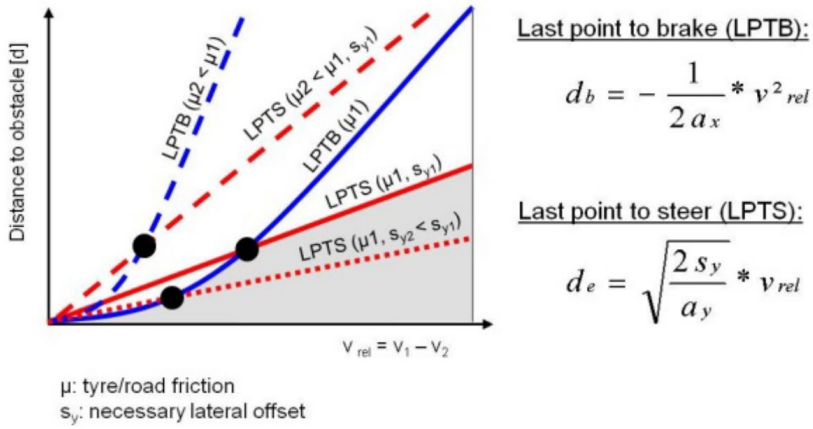

Figure 1 Last Point to Steer (LPTS) and Last Point to Brake (LPTB) general comparison (Continental AG)[8]

At high speeds, drivers usually find it more appropriate to steer their vehicle around obstacles. While planning this maneuver, system initiated emergency braking earlier than the driver would have otherwise chosen to steer would be perceived by the driver as a false activation. In alignment with NHTSA's commentary noted above, Porsche believes that

[8] Emergency Steer and Brake Assist – A Systematic Approach for System Integration of Two Complementary Driver Assistance Systems (Eckert, Continental AG, Paper Number 11-0111)

high-speed driving may be a scenario reflective of NHTSA's statement indicating "*…AEB activation may not increase safety and in some rare cases may increase risk*."

Porsche recognizes that in the proposal, NHTSA is intending for AEB and PAEB systems to operate at all speeds, up to and including the maximum capable speed of the vehicle. As outlined in the preamble and proposed regulatory text NHTSA propose AEB systems operate:

> *"…at all speeds above 10 km/h (6.2 mph), even if these speeds are above the speeds tested by NHTSA and provide at least some level of AEB system performance in those rear-end crashes. An AEB system active at any speed above 10 km/h (6.2 mph) will be able to mitigate collisions at high speeds through, at a minimum, speed reduction."*[9]

This preamble discussion is reflected in regulatory text for Part 571.127 S5.1.1 and S5.2.1 that states that the AEB system "must operate at <u>any forward speed</u> greater than 10km/h (6.2mph)…" This means that AEB systems would be required to remain operational at any speed up to the maximum speed of each vehicle.

Porsche recommends that at higher speeds, AEB operation be focused on dynamic brake support (DBS) and AEB warning as defined in S5.1.1 and S5.2.1. For the lead vehicle, this would apply to speeds above 100 km/h and for pedestrian this would apply to speeds above 65 km/h. Crash imminent braking (CIB) would be required to operate above 10 km/h and up to the speeds listed above. Narrowing the definition of AEB above the recommended speeds would ensure that drivers continue to receive warnings and that drivers who initiate braking would continue to be supported by DBS, but that drivers who may otherwise decide on a steering response would not have their vehicle initiate a CIB operation prior to the driver's full opportunity to steer.

Proposed revisions to S5.1.2 and S5.2.2 could include the following language:

> ***S5.1.2:*** *"Automatic Emergency Braking. A vehicle is required to have an automatic emergency braking system, as defined in S4 of this section, that applies the service brakes automatically when a collision with a lead vehicle is imminent. The* ***Crash Imminent Braking*** *functionality of the automatic emergency brake system must operate when the vehicle is traveling at any forward speed greater than 10 km/h (6.2 mph)* ***and less than 100 km/h (62.1 mph). Beyond 100 km/h, the AEB system provides warnings and dynamic brake support."***
>
> **S5.2.2**: "*Automatic Emergency Braking.* A vehicle is required to have an automatic emergency braking system, as defined in S4 of this section, that applies the service brakes automatically when a collision with a pedestrian is imminent. *The* ***Crash Imminent Braking*** *functionality of the automatic emergency brake system must operate when the vehicle is traveling at any forward speed greater than 10 km/h (6.2 mph)* ***and less than 65 km/h (40.4 mph). Beyond 65 km/h, the AEB system provides warnings and dynamic brake support.****"*

[9] 88 FR 38635

1.5. General considerations on "No-Contact" Requirements.

As is discussed within the comments from AFAI, Porsche agrees that AEB and PAEB systems can deliver benefits even in situations in which "no contact" cannot be achieved. AEB operation can reduce the overall potential energy of a collision event and this reduced collision energy can then be managed by passive safety systems on the vehicle. While a "no contact" outcome may appear to be the most beneficial approach specific to the potential collision itself, the challenges arise regarding the possibility for increased false activations and other unexpected braking performance and the potential issues that increased false activation could have on other vehicles and road users.

The goal of "no-contact" at higher speeds may best be implemented by NHTSA within NCAP and not by requiring such a demanding level of performance directly into vehicle compliance. As noted by NHTSA, NCAP provides an opportunity to push the boundaries of performance by aligning the highest ratings with the leading edge of currently available safety technology. NCAP can incentivize manufacturers to push investment and development to achieve these high ratings, but to do so in a more flexible manner than through compliance requirements. FMVSS defines the base-line performance that must be ensured robustly for all vehicles. Given the implications of a failed compliance test, manufacturers must design the system to be sure that compliance is achieved in all test cases under a vast set of conditions. For AEB, the necessary compliance margin has significant implications for system design and thus, for real-world performance. A no-contact requirement in compliance testing at high speeds inevitably leads to extremely cautious system design, which essentially requires OEMs to initiate emergency warnings and braking so early that it would be perceived as false-positive by customers in many real-world situations.

Porsche supports the positions raised by the AFAI with regards to aligning "no contact" and minimum speed reduction as implemented within UN-R 152. Porsche believes that this approach provides opportunities to achieve "no contact" at speeds in which this is practicable, while requires minimum speed reductions to help mitigate the severity of impacts at other speeds in which "no contact" is not practicable. This blended approach helps balance the performance of the systems to avoid or mitigate the severity of accidents while not producing excessive false activations. Porsche recommends that for speeds above the thresholds outlined in UN-R 152, it would be possible to develop extrapolated requirements with further analysis. While alignment with UN-R 152 would help facilitate a faster adoption overall, Porsche does recognize that older architectures would still need further development to overcome technical challenges. Other options beyond alignment with UN-R 152 could also be possible as described in the AFAI comments but would likely require additional time to develop.

1.6. Extent of AEB System Upgrades Needed to Comply with Proposed Standards.

As outlined within the AFAI comments, Porsche agrees that the proposed standards will drive significant AEB system upgrades beyond the software-only level of effort claimed by NHTSA. While many current Porsche vehicles in the US feature AEB systems, these existing systems were architected and designed to avoid collisions under different performance criteria. As such, existing AEB systems will require extensive hardware reengineering, in addition to updated software to potentially comply with the proposed AEB and PAEB performance requirements outlined in this NPRM. However, this outlook is inclusive of the agency altering AEB and PAEB boundary conditions as outlined

elsewhere in these comments, such as with required operation at high speeds. In addition, the extent of reengineering is further expanded due to the proposed warning requirements that would require extensive rework to complex assemblies, such as dashboards, in order to integrate Heads-Up-Displays (HUDs) or other visual warning cues.

At this point, Porsche believes that performance standards significantly beyond UN-R 152 would likely require multiple sensor types and for the sensor data to be integrated into "sensor fusion". For platforms not already equipped with multi-sensor input, this would increase the demands on network communication, data processing, and other hardware. Integrating all-new sensor hardware into existing electrical architectures can be highly expensive and feature lengthy design times given that electrical architectures are often shared across various model lines.

In addition, Porsche's approach to verification and validation of AEB performance is a lengthy process that requires time for simulation and extensive on-road assessments in order to ensure that changes to systems continue to perform as expected and do not introduce unintended consequences. This applies not only to the AEB system. Changes to the sensor suite of a vehicle require re-validation of all other systems that use this sensor.

Engineering resource and capital expenditures needed to redesign AEB systems would need to be amortized across a high volume of models in order to recoup the costs over time. For Porsche, the challenge is that many of the existing architectures underpinning combustion-based models will be phased out over the next several years as Porsche transitions the vehicle product mix increasingly towards all-new electrified vehicles. Reengineering legacy platforms would require a high degree of expenditure which would increase the per vehicle cost over the remaining life-cycle of that platform, or could result in potentially forcing the early withdrawal of vehicles from the US market reducing consumer choice in vehicles.

Porsche envisions that future electrified models will be able to leverage the electrical, sensor, processing and network upgrades that will be embedded within the newer architectures. As such, these newer vehicles will have a higher starting point of capability and will likely require less extensive redesign in order to meet the proposed standards with the modifications described in these comments.

2. <u>Comments Specific to Lead-Time and Phase-In.</u>

As noted above in Section 1.6, the proposed standards would drive extensive reengineering of AEB systems and vehicle architectures for Porsche. The increased technical requirements would increase system and vehicle costs and would require long lead-times to manage the development and validation needed to ensure robust performance.

Porsche vehicles also tend to have extended product life cycles due to the low volume and limited market range of the passenger cars and multipurpose passenger vehicles offered in the US, meaning existing architectures could remain in the market for several years into the proposed effective timing of this rule. In addition, Porsche is transitioning its overall global fleet to accelerate the deployment of electric vehicles as part of Porsche's global decarbonization efforts and for

compliance with regional emissions, fuel economy and greenhouse gas regulations. This architectural transformation is slated to occur over a time period that extends into the effective timing of the proposed rule.

Given both the reengineering timing and architectural transition, Porsche projects that the NPRM's proposed three and four-year lead-time would not be sufficient for Porsche to achieve full compliance with the proposed requirements and would disrupt Porsche's planned product offerings. As such, Porsche proposes the following revised lead-time allowance, including the use of a phase-in, and early action compliance credits as outlined below. Further context regarding Porsche's proposal is provided in **Appendix-C** (Section Marked CONFIDENTIAL). While Porsche recognizes that NHTSA did not include percent-based phase-ins or the use of early action credits in the NPRM, Porsche believes that both of these mechanisms are within scope of the NPRM given that each of these mechanisms have extensive regulatory history and are commonly used by NHTSA and other Federal and State agencies in helping to manage compliance with new or updated regulations. The three elements are summarized in the following sections and in Table 1 and Figure 2 below.

2.1. Proposal for extended lead-time, phase-in and early action compliance.

Porsche proposes the following update to S5. In general, the recommendation would leverage three commonly employed regulatory mechanisms to help ensure that the full fleetwide compliance with the proposed AEB standards can be achievable.

Extension of Lead-Time by One Year for Each of the Two Compliance Phases

- Providing an additional year of lead-time will be necessary for Porsche to complete the development and validation tasks for initial systems and vehicles to achieve compliance with the proposed standards.
- Porsche recommends compliance with the "Phase-1" requirements[10], generally the requirements as described in S5.(a) with the exceptions outlined in S5.(b) and (c), to begin four calendar years following the publication of the Final Rule. This is one year later than proposed by NHTSA.
- Porsche recommends that "Phase-2" higher-speed PAEB requirements begin the following September 1st after Phase-1 or the first September 1st five years following publication of the Final Rule.

Addition of a Fleet Phase-In Percentages

- Porsche recommends the use of a fleet phase-in for each manufacturer to help each manufacturer systematically upgrade the range of AEB systems and vehicle applications across their fleet. The phase-ins proposed would begin with the lead-time start dates above.
- Porsche recommends that compliance with the "Phase-1" requirements include the use of a four-year phase-in. The phase-in would begin with the lead-time as described above and would be a percentage of each manufacturer's fleet sold in the US. Suggested phase-in percentages are shown in Table 1 below. Porsche

[10] For ease of reference, Porsche is generally referring to the lead-vehicle AEB and lower-speed PAEB requirements as "Phase-1" and the higher-speed PAEB requirements as "Phase-2". As described in the NPRM, Phase-1 is proposed to begin the first September 1st three years following publication of the Final Rule and Phase-2 the fourth September 1st.

recommends a phase-in of 25%, 50%, 75% and 100% beginning on the first September 1st four calendar years after the publication of the Final Rule. This linear phase-in is consistent with other prior rulemakings.

- Porsche recommends that compliance with the "Phase-2" requirements include the use of a four-year phase-in specific to the Phase-2 requirements. The phase-in would begin with the lead-time as described above and would be a percentage of each manufacturer's fleet sold in the US. Phase-in percentage points are shown in Table 1 below. Porsche recommends a phase-in of 25%, 50%, 75% and 100% beginning on the first September 1st five calendar years after the publication of the Final Rule.

Inclusion of Early Action Compliance Credits to Incentivize Early Deployment

- Despite the general challenges being addressed by the recommended lead-time and phase-in provisions, Porsche recommends NHTSA consider the inclusion of early action credits that manufacturers could earn by bringing compliant vehicles to market sooner than required. Early action credits are a valuable compliance flexibility that can accelerate safety benefits by incentivizing early system deployment. These credits are helpful for manufacturers in meeting phase-in requirements.
- Porsche recommends that NHTSA provide early action compliance credits for the Phase-1 and separately for the Phase-2. Manufacturers who bring compliant vehicles one year prior to the start of the phase-in could "bank" up to 20% points in each of the phase-ins and then apply those points in determining compliance with the first three years of each of the phase-ins. (See example below)
- As mentioned previously, the early action credits would provide accelerated safety benefits and compliance flexibility for manufacturers. In addition, the cap of 20% would ensure that manufacturers must continue to make ratable progress towards full adoption. Finally, limiting the use of the early action credits to only the first three years of the phase-in would provide NHTSA with certainly regarding the timeline for full compliance for the industry overall.

Table 1 Porsche Proposed Lead-Time, Phase-In and Early Action Credits for Part 571.127

First September 1st XX Calendar Years after Final Rule	**Phase-1 AEB and Low Speed PAEB**	**Phase-2 Higher Speed PAEB**
Three Calendar Years	Early Action Credits (up to 20%)*	n/a
Four Calendar Years	Min. 25%	Early Action Credits (up to 20%)**
Five Calendar Years	Min. 50%	Min. 25%
Six Calendar Years	Min. 75%	Min. 50%
Seven Calendar Years	100%	Min. 75%
		100%

* Phase-1 Early Action percentage credits useable in the first two model years of Phase-1 compliance

** Phase-2 Early Action percentage credits useable in the first two model of Phase-2 compliance

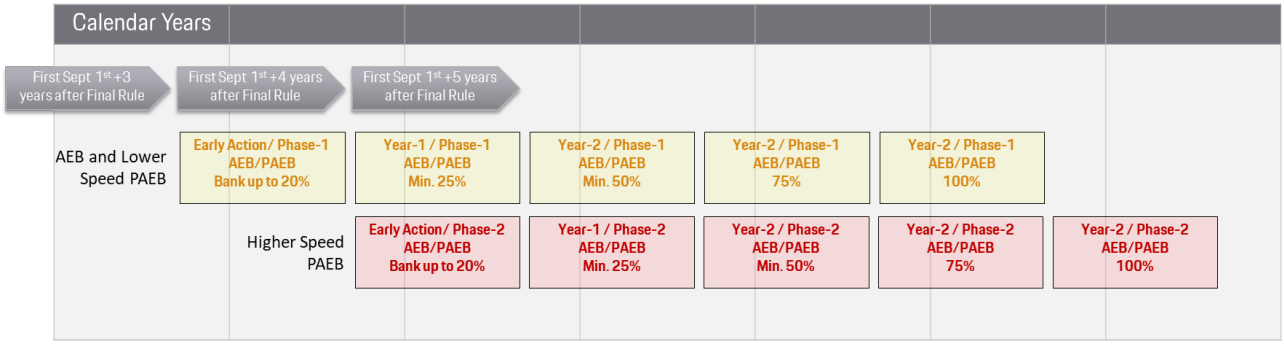

Figure 2 Summary of lead-time, phase-in and early action credit proposal

Example of Early Action Credits:

- Assume NHTSA publishes a Final Rule on August 1, 2024. The first September 1st three calendar years after publication of the Final Rule would be September 1, 2027.
- Starting September 1, 2027, Manufacturer-A can certify 20% of its light vehicles to comply early with the AEB and PAEB requirements of "Phase-1".
    - Manufacturer-A earns 20% early action percent credits.
    - Manufacturer-A banks these credits for use in Year-1, Year-2, and Year-3 phase-in requirements.
    - In Year-1 of the Phase-1 phase-in, Manufacturer-A can certify 22% of its light vehicles to comply with Phase-1 requirements.
        - Manufacturer-A uses 3% points from its bank of early action credits to demonstrate compliance with the phase-1 requirement of 25%
        - 17% early action credits remain available for Year-2
    - In Year-2 of the Phase-1 phase-in, Manufacturer-A is able to certify 40% of its light vehicles to comply with Phase-1 requirements.
        - Manufacturer-A uses 10% points from its bank of early action credits to demonstrate compliance with the phase-1 requirement of 50%
        - Remaining 7% early action credits can be used in Year-3 or would otherwise expire
    - In Year-4, Manufacturer-A must demonstrate 100% compliance with the requirements of Phase-1 without the use of early action credits.

2.2. Alternative end-of-life flexibility.

In the alternative to the above referenced recommendation for extended lead-time, phase-in and early action credits, Porsche recommends that NHTSA consider excluding vehicles from compliance with an end-of-production date prior to a specific time-period, such as with an end-of-life of September 1, 2030. This approach could be modeled on the

approach used within the industry voluntary commitment[11] for AEB in recognition of the challenges associated with reengineering vehicles near end-of-life.

Recognizing that NHTSA has found the level of performance associated with systems that meet the definitions within the voluntary commitment as a baseline level of performance for the industry, Porsche recommends that NHTSA include an alternative minimum level of performance for end-of-life vehicles to be excluded. NHTSA could reference that a manufacturer must declare that vehicles being considered for end-of-life exclusion are able to comply with UN-R 152 requirements. UN-R 152 provides a well-established level of performance requirements for AEB systems and is currently recognized by many jurisdictions outside of the US. By demonstrating that end-of-life exclusion vehicles are meeting UN-R 152 requirements, NHTSA can ensure that the vehicles being excluded from compliance with Part 571.127 are providing incremental performance capabilities above and beyond the baseline level of performance associated with the conditions of the voluntary agreement.

3. Comments Specific to the Proposed Lead Vehicle AEB Requirements.

Porsche provides the following comments specific to the lead vehicle requirements in S5.1 and the associated sections for lead vehicle test procedures, conditions, and requirements.

3.1. The high relative speeds and low headway values exceed the capabilities of current AEB systems.

The leading global standard for AEB operation is the UN R-152. This standard currently requires full collision avoidance up to 40 kph relative speed between the subject and lead vehicle. NHTSA's proposed regulation requires double the relative velocity between the subject and lead vehicle representing a significant increase in the system technical performance requirements. AEB system design is an optimization process between system performance, availability, and robustness. In this context, robustness describes the ability of the system to avoid false positives in real-world scenario. Increased performance demands are likely to result in reduced robustness, i.e., an increased false positive rate, leading to phenomena such as "phantom braking".

To double the relative speed up to which the system must avoid a collision, the system must initiate emergency braking farther in advance from the obstacle. Earlier braking means that the system looks further ahead, both in space and in time. At this point, the probability of collision is estimated at a lower accuracy compared to conditions that must be considered in standards like UN-R 152. Manufacturers design AEB systems to account for real-world conditions, rather than well-defined test scenarios. However, as the regulated test requirements are drastically increased, this may impact the robustness of the system in real-world performance, potentially leading to increased instances of premature, or unnecessary braking and warning in the real-world.

[11] Commitments to Advancing Automatic Emergency Braking Technology, March 2016

Proposed Modifications to S7.5 Decelerating Lead Vehicle

1) For the 80 kph test condition, increase the lower headway range from 12m to 25m.
    - Porsche does not support the lower headway range defined in S5.7 of 12m and believes this is not appropriate or reflective of normal on-road driving.
    - Porsche believes that the 12m headway range at 80 kph is reckless and likely would constitute illegal driving (i.e., "tailgating"). Providing robust AEB performance at 80 kph and with a close distance such as 12m would exceed the practical technical capabilities of many AEB systems.
    - Compliance with this combination of close headway and high velocity would likely trigger immediate emergency braking at maximum deceleration and could result in increased risk for the driver or other vehicles in the subject vehicles proximity.
    - Porsche recommends increasing the minimum headway specific to the 80 kph test condition in S7.5(b)(2) to 25m for 80 kph test.

4. Comments Specific to the Proposed Pedestrian PAEB Requirements.

Porsche provides the following comments specific to the PAEB requirements in S5.2 and the associated sections for pedestrian test procedures, conditions, and requirements.

4.1. Nighttime performance.

Porsche contends that the required nighttime PAEB performance requirements at the higher relative speeds is likely to exceed the technical capabilities of many current AEB system hardware. The functional logic in perception systems varies with the performance and robustness of the equipped sensors. The trigger decision can either be based on a single sensor detection or multiple sensors which can provide additional confirmation of detection and classification. This impacts the True-Positive and False-Positive rates.

The proposed PAEB requirements under low-beam conditions could exceed the technical capability for single-sensor systems to robustly achieve:

Radar based systems are unlikely to achieve robust low-beam PAEB performance.

- Radar sensors are limited by their resolution in correctly classifying pedestrians and may need to be complimented with a camera sensor for classification of the detected objects.

Camera based systems are unlikely to achieve robust low-beam PAEB performance.

- The perception of camera systems in low light situations (e.g., low beam without external illumination) is limited to the range of the headlight cone. Based on Porsche's initial assessment, camera-based systems may not be

able to detect the crossing pedestrian in time at the proposed speed under lighting conditions according to FMVSS 108.

- Therefore, camera only systems are unlikely to fulfill the proposed collision avoidance requirements.

Current vehicle projects using single-sensor systems would need fundamental hardware architectural updates to integrate all-new sensors in addition to extensive software updates, both of which would increase overall system costs. The obstructed scenarios remain a challenge even for fusion-based systems. The latency for sensor fusion is highly dependent on the vehicle architecture and electronics hardware and is generally higher for fusion-based systems compared to single-sensor.

Porsche proposes that in general, NHTSA should align the daylight PAEB requirements with UN-R 152. This harmonization would help ensure that the requirements are achievable with existing technologies and that can be quickly put into a minimum FMVSS requirement.

The proposed night requirements, especially those specific to low-beam operation, pose significant challenges for current systems given the minimum level of illumination that is needed for most current generation camera systems to identify, capture, and process an image. Porsche recognizes that Part 571.108 imparts illumination limits that are intended to avoid excessively bright headlights that could harm other drivers or road users. These illumination limits inhibit the range at which cameras can reliably identify, capture, and process images needed to decide on AEB operation. This is relevant whether the camera is operating alone as a single sensor or in tandem with another sensor, such as radar, in which AEB activation is often triggered by consensus between the two sensors.

Obstructed conditions would also need further evaluation in order to ensure a robust test procedure and achievable standard. The challenge in this case is primarily related to system latency.

4.2. High speed PAEB requires vehicles to predict whether pedestrians will step on the road.

Similar to AEB, for PAEB, the last point to brake moves out quadratically with increased speed. At the speeds proposed in the NPRM, this may require the vehicle to predict the decision of pedestrians to step on the road or to stop short of it. In order to meet the requirements, the vehicle will have to assume the worst case. Under real-world conditions, this leads to an elevated level of false positives when pedestrians move adjacent to the road.

For the small overlap (i.e., 25% test conditions), the last point to steer lies is much closer to the pedestrian than the last point to brake. The proposed test speeds may increase the likelihood for emergency braking engagement that may often be perceived by the customer as a false activation in scenarios where the driver is aware of the pedestrian on the road and planning to steer around them. This dilemma is similar to high speed AEB for lead vehicles, but occurs at lower speeds, as small overlap pedestrian scenarios are harder to detect and predict.

5. Comments Specific to the Proposed False Activation Requirements.

Porsche provides the following comments specific to the proposed false activation requirements of S9. And in the general discussion within the preamble

Porsche recommends NHTSA consider aligning false activation test requirements with those found in UN-R 152. In general, the specified test requirements in the regulation only serve as a small set of conditions that are used within the overall functional safety development for AEB systems and while helpful in demonstrating some system functionalities are not comprehensive in ensuring robust on-road performance.

Robustness (i.e., the mitigation of false positive warning/braking events) is a top priority in the development of AEB systems. AEB system design must balance false positives and false negatives. Reducing the likelihood of false activations is important to ensuring customer acceptance of the system and to avoid having customers reject the technology or to casually deactivating the system. Porsche leverages an intensive functional development process incorporating systematic validation and verification, that aims to ensure robust, balanced real-world performance. While not proposed, Porsche could be supportive of a documentation-based compliance system for certification of AEB systems in the US, similar to the process used in other markets. However, the details of how this would be implemented would require additional discussion with the industry overall. Porsche recommends that NHTSA continue to explore this pathway for potential future updates to AEB regulations.

Porsche finds that the discussion regarding onboard vehicle data storage is not a suitable option for the intended purpose of evaluating system performance and to judge whether activation was justified. In order to have the ability to review individual cases, vehicles would need to process and store significant volumes of data from sensors such as cameras. Storing significant volumes of image data would not be practicable with most current vehicle platforms due to processing and storage limitations of the electrical architectures. Porsche recommends, as mentioned above, that the agency explore other options such as documentation to ensure robust real-world performance.

5.1. False Activation Test Specifications.

Porsche provides the following minor suggested edits to the false activation vehicle pass-through and steel trench plate tests in S9.

Pass through test in S9.3

- Porsche recommends modifying the reference to the lateral distance for the pass-through gap in S9.3.1(b) to be in relation to the exterior of the vehicle body instead of to the front wheels.

Manual brake application requirements in S9.2 and S9.3

- In S9.2.1(d) and S9.3.1(d), it is not immediately obvious if testing is required for both conditions of with and without manual brake application.
- Porsche recommends NHTSA add a test matrix table similar to Table-1 for S7.1 and Table-2 for S8.1 to help clarify the required test scenarios.

6. Comments Specific to the Proposed Test Procedures in Various Sections of Part 571.127.

Porsche provides the following comments specific to test procedures found throughout sections of the proposed Part 571.27. These comments reflect learnings from previous NCAP and UN ECE experiences and are aimed at helping to improve the robustness of the test procedures.

6.1. Repetition of test runs for compliance demonstration + well defined enforcement testing.

Because of the proposed structure of the regulation using ranges of speeds, vehicle conditions, and environmental factors, there is an infinite number of combinations of parameters that could be tested as part of a compliance assessment. As such, Porche recommends that NHTSA provide more specific test parameters that could be used in a compliance test and to provide some flexibility should failed test results be encountered.

Porsche supports the comments submitted by AFAI regarding the conduction of multiple test runs in the event of a failed test. AEB technology leveraging the use of perception algorithms is an inherently probabilistic technology. AEB must process high volumes of data in deciding on whether to initiate emergency braking. Given the wide range of conditions within the proposed regulation, and variables in physical testing, any comprehensive assessment of the system can come across situations in which there can be an occasional single failed test run that is not otherwise indicative of a non-compliant system. As demonstrated during development of UN-R 152, systems with very robust performance can achieve > 99% probability to pass each test, but are ultimately not infallible under each and every test. As such, Porsche believes it is important for NHTSA to adopt flexibilities within compliance testing that allows for limited retests of systems to provide a more comprehensive determination of system compliance. Porsche recommends alignment with the UN-R 152. As outlined in section 6.10 of UN-R 152, the standard allows for limited retesting combined with root-cause analysis of failed tests. This flexibility allows retesting to determine if the failure was an anomaly or indicative of system underperformance. These measures ensure that failed tests are limited and are assessed as part of the allowance for resting.

6.2. Additional details specific to the Subject Vehicle Brake Application Procedure.

Porsche requests that NHTSA provide additional clarity specific to the brake robot application and believes this should be updated. Porsche recommends that additional detail be provided in S.10 specific to the set-up and calibration of the braking robot in order to help improve repeatability and robustness of testing. Porsche also believes that changes can be made to the braking procedure to be more reflective of on-road braking behavior of drivers in emergency situations.

Porsche has experience from other AEB testing that due to lack of specification for the braking robot, each test equipment manufacturer may have unique details regarding their implementation and operation of their robot. The rate

of brake pedal application is an important variable and should be reflective of human performance by incorporating both travel distance and force application.

6.3. Vehicle conditioning before testing.

Porsche recommends that vehicles should be warmed up prior to testing in order to ensure that all fluids, tires, brakes and other systems are at their normal operating temperature ranges and conditions. This warm-up period also accounts for any sensor recalibration that could be necessary as a result of handling the vehicle prior to testing. Porsche recommends adding a new section within S6.3 (Lead Vehicle) to include reference to vehicles being "warmed-up". Porsche recommends alignment with warm-up language in UN-R 152, section 6.2.2 Pre-Test Conditioning, to account for both warm-up of the service brake system and sensor calibration. UN-R 152 details the operation of the vehicle in both urban and rural environments that may help calibrate the camera and other sensors against a variety of conditions.

6.4. General improvements to test specifications.

Porsche recommends that NHTSA include a specification within the proposed S8.3.3.:

> "(j) The pedestrian test mannequin is set up xx +/- x.x m to the front of the front most parallel plane of the lead stationary vehicle test device".

Porsche recommends that the distance between the pedestrian test dummy and the furthest obstructing vehicle be specified. The level of obstruction of the child test dummy can only be defined by this distance. If multiple distances are required to reflect full and partial obstruction, then each specific test scenario should be defined, including the distance, in the direction of travel of the subject vehicle, between the test dummy and the front of the lead test vehicle.

6.5. The proposed test devices are adequate.

Porsche supports NHTSA's proposal to adopt ISO PAEB Dummy specifications. For detection reasons, Porsche supports the adoption of articulated dummies with at least moving legs. The articulated motion is required because of the "micro doppler" effect which is an important consideration for radar sensors.

7. Comments Specific to the Proposed AEB Warning and Visual Telltale Requirements.

The following comments provide feedback specific to the AEB and PAEB warning and visual tell-tale requirements specified in the proposed NPRM in sections S5.1.1, S5.2.1, S5.4, and in SAE J2400 as incorporated by reference. In general, Porsche is supportive of the requirements for meaningful visual and audible warnings for drivers, but feels that the proposal may be overly prescriptive with regards to the audible signal and could require extensive reengineering to implement the proposed visual warnings. Porsche's comments seek additional flexibility and alignment with UN-R 152.

7.1. Manufacturers should have flexibility in the implementation of audible collision warning details.

In reviewing the proposal, Porsche believes that the audible warning requirements for AEB are overly prescriptive. Discretion should be afforded to manufacturers to determine an auditory signal that is appropriate to warn the driver of an immediate forward crash. Providing manufacturer flexibility in determining an appropriate audible warning may better accommodate future warning strategies that may evolve with next generation AEB systems and vehicle-driver interfaces. Manufacturers would still be required to ensure that their audible warning is appropriate in providing a warning that is easily perceivable and distinguishable from other warnings.

Porsche recommends that the final rule remove the specifics related to the audible warning found in S5. for frequency, duty cycle and tempo. For example, Porsche has found that a continuous, but highly audible acoustic warning is state of the art in many manufacturers implementation of FCW systems and already has demonstrated customer acceptance in the field - customers of FCW equipped vehicles will most likely link the current FCW auditory warning to an urgent situation that requires immediate drivers' attention and reaction. Forcing a change in the existing audible warnings due to prescriptive requirements in Part 571.127 may upend the customer familiarity achieved to date.

7.2. Manufacturers should have flexibility in the implementation of visual collision warning details.

Like the findings with regards to audible warnings, Porsche believes that the visible warning requirements for AEB are overly prescriptive, preclude the use of ISO symbols, and would require extensive reengineering of dashboards to implement full-scale Heads-Up-Displays (HUDs). Manufacturers should be provided with more flexibility to implement visual warnings while ensuring that the warnings are easily perceivable and distinguishable from other warnings.

The major effect of the visual collision warning is not based on the shape of the symbol but rather the color. FMVSS 101 provisions (S5.6) should be adopted regarding the visuals.

Specific to the 10-degree cone requirement for visual warnings, Porsche believes that this requirement will generally require the full integration of HUDs into all vehicles which in turn will demand excessive reengineering of dashboards and integration of expensive hardware. Furthermore, HUD systems may not be appropriate for the display of safety critical warnings due to inherent limitations and the possibility of HUD visual impairments.

HUD systems are currently available on certain Porsche models as optional equipment, however due to the system complexity and hardware, the option price can approach upwards of $1000 for the customer. Should the final rule adopt the 10° cone requirement, Porsche may have to implement HUDs throughout the entire vehicle line up which would drive broad cost increases for vehicles. Furthermore, HUD system displays can sometimes be obscured. For example, drivers with polarized sunglasses may not be able to see the HUD display reliably. In other cases, drivers with high or low stature may have difficulty in seeing the HUD even with the visual adjustments provided. Finally, in most HUD implementations, the drivers are permitted to turn-off the HUD and other regulations such as UN-R 125 require disablement[12]. Due to some of these limitations, Porsche generally does not use HUDs to display safety-critical

[12] UN. Regulation 125, Forward Field of Vision of Drivers

warnings. In terms of functional safety, this would require a different ASIL[13] rating for the HUD, which would driver further hardware changes and complexity to the system. Porsche recommends that NHTSA consider replacing the 10-degree reference in SAE J2400 with an allowance of up to 30-degrees. This additional visual allowance will facilitate the use of long-established visual warning locations which to date appear to be sufficient in providing drivers with easily perceivable and distinguishable cues.

Finally, Porsche recommends that NHTSA reconsider the flexibility for manufacturers to use the ISO 7000-2681 symbol in place of the SAE J2400 4.1.16 symbol. Porsche recognizes that the ISO symbol depicts a lead vehicle scenario, but has found that drivers are not observed to be confused regarding the purpose of symbol in depicting an imminent forward collision in general, regardless of whether the tested condition is against another vehicle or pedestrian. To reduce system complexity and better harmonize with ither AEB standards, Porsche recommends that references to the visual symbol in S5.1.1 and S5.2.1 also include reference to ISO 7000-2681. The ISO standard would need to be added into the incorporated by references section of Part 571.5.

Proposed modifications to S5.1.1 and S5.2.1.

- Porsche proposes the following modifications to S5.1.1 and S5.2.1 to account for both the recommended 20-degree cone and the allowance of ISO 7000 symbol:

  "The visual signal must be located according to SAE J2400 (incorporated by reference see § Part 571.5), paragraph 4.1.14, ***except that the visual warning shall be located within a 30-degree cone of the driver's line of sight****, and must include* ***either*** *the symbol in the bottom right of paragraph 4.1.16* ***or the forward collision warning symbol in ISO 7000-2681****."*

7.3. Muting of auditory channels should not be required.

Porsche recognizes NHTSA's proposal to mute other vehicle systems when the AEB audible system warning is activated. However, there are two issues regarding this proposal. The first is that muting of other systems could impact existing vehicle electrical architectures which do not have full capability for various systems to communicate sufficiently to force simultaneous muting across multiple sub-systems that may be operated by different controllers. An emergency system controller may not have the existing communications and control pathways needed to override another system governed by a separate controller. This would require reengineering system architecture on legacy platforms. Some newer platforms that feature greater vehicle-wide system integration may be better equipped to handle this functionality. Separately, the muting specifics would need to be better defined in the case where multiple warnings occur simultaneously. The proposal is not sufficiently clear as to develop a warning hierarchy.

Porsche develops warning processes that typically employs a combination of a general but intense continuous acoustic tone, capable of achieving very quick driver awareness, together with a dedicated visual symbol to inform the driver of the criticality of an emergency. Porsche has found audible/visual combinations to be appropriate and sufficient. The

[13] Automotive Safety Integrity Level per ISO 26262

driver can easily relate to the FCW due to the characteristics of the warning tone in distinction to less relevant warning tones. Porsche does not believe that muting of other sound sources in the vehicle is necessary, because the combination of warning tone and visual warning should allow the driver to adequately recognize the situation. Furthermore, muting is not included in any regulation for an acoustic warning. Porsche recommends that drivers always operate their vehicle with awareness of the vehicle state and the general situation around the vehicle. Audio systems should not be used in a manner that interferes with the driver's full attention to the driving task, and this includes the perception of acoustic signals from his own vehicle and surrounding traffic.

Porsche recommends that NHTSA remove this specific requirement in this Final Rule and instead defer the topic to a later rulemaking in any future updates of Part 571.127.

7.4. Warning timing should be adopted.

To minimize driver annoyance and reduce the number of 'false positive' collision warnings, in appropriate situations manufacturers should be permitted to issue the forward collision warning at the same time as an AEB intervention. In certain situations, the need to have the sequence of forward collision warning and then AEB intervention, leads to earlier collision warnings than necessary and later AEB interventions.

Porsche recommends the following modifications to S5.1.3 and S5.2.3:

> S5.1.3. *Performance Test Requirements.* The vehicle must provide a forward collision warning **at the latest, when the AEB is activated. The vehicle must** subsequently apply the service brakes automatically when a collision with a lead vehicle is imminent such that the subject vehicle does not collide with the lead vehicle when tested using the procedures in S7 under the conditions specified in S6. The forward collision warning is not required if adaptive cruise control is engaged.
>
> S5.2.3. *Performance Test Requirements*. The vehicle must automatically apply the brakes and alert the vehicle operator, **at the latest, when the AEB is activated,** such that the subject vehicle does not collide with the pedestrian test mannequin when tested using the procedures in S8 under the conditions specified in S6.

7.5. Haptic warnings should not be mandatory.

Porsche recommends that NHTSA not adopt a mandatory haptic signal for drivers for AEB operation. As mentioned above, Porsche contends that the current strategy of audible and visual warnings is sufficient for driver awareness. In some cases, Porsche may utilize a brake jerk to provide additional information if there is a delayed reaction from the driver. However, Porsche typically is not considering other haptic warnings, due to the potential to be overly disruptive to drivers and cause annoyances which will result in reduced consumer acceptance. In addition, Porsche seeks to avoid causing driver confusion related to other safety systems where haptic signals may be more appropriate (e.g., steering wheel vibration used for lane keeping).

7.6. Align malfunction warning requirements with UN-R 152.

Porsche recommends NHTSA to align malfunction requirements with the details specified in UN-R 152. The standard provides requirements for malfunction indication relative to specific conditions for the AEB system. UN-R 152 differentiates between conditions such as momentary initialization, electrical failures, sensor obstructions or "blindness", and deactivation. Porsche believes that the malfunction requirements in UN-R152 are effective and clearly communicate the status of the system to the driver. In addition, harmonization with UN-R 152 will help align global implementation.

—Appendix B—

Appendix B. Proposed regulatory text for AEB and PAEB Manual Deactivation.

Porsche provides the following language as suggested implementation for the manual deactivation of AEB based on the similar allowance for ESC Off found in Part 571.126 S5.4. Using the established ESC language should help streamline adoption and provide NHTSA and manufacturers with a proven structure. Porsche also recommends conforming amendments to Part 571.101 for associated telltales and text.

Amend proposed Part 571.127 by adding new paragraph S11.

S11. ***AEB Off and Other System Controls.*** The manufacturer may include an "AEB Off" control whose only purpose is to place the AEB system in a mode or modes in which it will no longer satisfy the performance requirements of S5. An "AEB Off" control may be combined with other controls in a multi-function control. Manufacturers may also provide controls for other systems that have an ancillary effect upon AEB operation. Controls of either kind that place the AEB system in a mode in which it will no longer satisfy the performance requirements of S5. are permitted, provided that:

S11.1 The operation of the vehicle control which places the AEB system in a mode or modes in which it will no longer satisfy the performance requirements of S5. must meet the following two requirements.

(a) require a minimum of two deliberate actions from the driver and;
(b) the control must only be accessible to the driver when the vehicle is moving at a speed equal to or less than 10 km/h (or 6.2 mph). Above this speed, the control must not be accessible by the driver.

S11.2 The vehicle's AEB system must always return to the manufacturer's original default AEB mode that satisfies the requirements of S5 at the initiation of each new start-run cycle, regardless of what AEB mode the driver had previously selected, unless the vehicle is in a low-range four-wheel drive configuration selected by the driver on the previous ignition cycle that is designed for low-speed, off-road driving

S11.3 In addition to the requirements of S11.1, if the vehicle's AEB system has more than one AEB mode that satisfies the requirements of S5. within the drive configuration selected for the previous ignition cycle, the system must return to the manufacturer's original default AEB mode.

S11.4 A control whose only purpose is to place the AEB system in a mode or modes in which it will no longer satisfy the performance requirements of S5 must be identified by the text, "AEB Off" as listed under "Word(s) or Abbreviations" in Table 1 of Standard No. 101 (49 CFR 571.101).

S11.5 A control for another system that has the ancillary effect of placing the AEB system in a mode in which it no longer satisfies the performance requirements of S5. must be identified by the "AEB Off" telltale in accordance with S11.5.

S11.6 ***AEB Off Telltale***

S11.6.1, The vehicle manufacturer must provide a telltale indicating that the vehicle has been put into a mode that renders it unable to satisfy the requirements of S5., if such a mode is provided.

S11.6.2 The "AEB Off" telltale must be identified by the text, "AEB Off" as listed under "Word(s) or Abbreviations" in Table 1 of Standard No. 101 (49 CFR 571.101).

S11.6.3 The "AEB Off" telltale must be mounted inside the occupant compartment in front of and in clear view of the driver.

S11.6.4 The "AEB Off" telltale must remain continuously illuminated for as long as the AEB is in a mode that renders it unable to satisfy the requirements of S5., and

S11.6.5 Notwithstanding S5.3.1(e) of 49 CFR 571.101, the vehicle manufacturer may use the "AEB Off" telltale to indicate an AEB level of function other than the fully functional default mode even if the vehicle would meet S5.

S11.6.6 Except as provided in paragraph S11.5.7 and S11.5.8, each "AEB Off" telltale must be activated as a check of lamp function either when the ignition locking system is turned to the "On" ("Run") position when the engine is not running, or when the ignition locking system is in a position between "On" ("Run") and "Start" that is designated by the manufacturer as a check position.

S116.7 The "AEB Off" telltale need not be activated when a starter interlock is in operation.

S11.6.8 The requirement S11.5.6 does not apply to telltales shown in a common space.

S11.6.9 The "AEB Off" telltale must extinguish after the AEB system has been returned to its fully functional default mode.

—Appendix C. Confidential—

Appendix C. Lead-Time and Phase-In Discussion.

--Page Confidential--

--Page Confidential--

--Page Confidential--